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Masses and luminosities for 342 stars from the PennState-Toruń Centre for Astronomy Planet Search *(Research Note)*

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ABSTRACT

Aims. We present revised basic stellar astrophysical parameters: masses, luminosities, ages and radii for 342 stars from PennState-Toruń Centre for Astronomy Planet Search. Atmospheric parameters for 327 stars are available from Zieliński et al. (2012), for the remaining 15 objects we present also spectroscopic atmospheric parameters: effective temperatures, surface gravities and iron abundances.
Methods. Spectroscopic atmospheric parameters were obtained with a standard spectroscopic analysis procedure, using ARES (Sousa et al. 2007) and MOOG (Sneden 1973) or TGVIT (Takeda et al. 2005) codes. To refine stellar masses, ages and luminosities we applied a Bayesian method based on Jørgensen & Lindegren (2005) formalism, modified by da Silva et al. (2006).
Results. The revised stellar masses for 342 stars and their uncertainties are generally lower than those presented in Zieliński et al. (2012). Atmospheric parameters for 13 objects are determined here for the first time.

Key words. stars: low-mass – stars: late-type – stars: fundamental parameters – stars: statistics

1. Introduction

Since the discovery of the first exoplanet through precise radial velocity measurements (Mayor & Queloz 1995) the technique proved to be the most versatile and resulted in detection of over 430 extrasolar planetary systems around stars at various evolutionary stages known today. By nature, the planetary masses delivered by this technique are uncertain to the $\sin i$ factor, due to the unknown orbital plane inclination, and relative to the stellar mass. From the perspective of proper interpretation of the nature of the extrasolar planetary systems, precise determinations of the mass of their hosts are therefore invaluable.

One of the indirect approaches to obtain stellar mass is to compare available observational data like detailed spectroscopically determined atmospheric parameters, photometry or luminosities to theoretic stellar evolutionary models, for instance by isochrone fitting (Flannery & Johnson 1982).

Given very approximate methodology applied in Zieliński et al. (2012) to derive stellar masses, we decided to revise previous results in a more sophisticated approach. The purpose of this paper is to constrain better masses, ages, radii and, when no parallax is available also luminosities, for red giants presented in Zieliński et al. (2012) through Bayesian probability approach (da Silva et al. 2006) and to deliver for the first time atmospheric parameters, masses, ages and luminosities for the 16 stars omitted in that paper.

The stars considered here come from the Red Giant Clump subsample of the ongoing PennState-Toruń Centre for Astronomy Planet Search (PTPS, Niedzielski et al. 2007; Niedzielski & Wolszczan 2008), a long-term project focused on detection and characterization of planetary systems around stars at various evolutionary stages. Stellar atmospheric parameters together with uncertainties, required in further mass, age, luminosity determination, were taken from Zieliński et al. (2012) where effective temperatures, surface gravities, metallicities and microturbulence velocities were derived using TGVIT (Takeda et al. 2005) from spectra obtained with the Hobby-Eberly Telescope (HET, Ramsey et al. 1998) and its High Resolution Spectrograph (HRS, Tull 1998) operated in the queue scheduled mode (Shetrone et al. 2007).

This paper is organized as follows: in Sect. 2 we describe the sample and the method used in determination of stellar atmospheric parameters. In Sect. 3 mathematical formalism and example of constructed probability distribution function are provided. The results, a comparison with parameters obtained by Zieliński et al. (2012) and others is presented in Sect. 4 while Sect. 5 contains conclusions.

2. The sample and atmospheric parameters

After we published the results of spectroscopic analysis for the first group of stars observed in our project (Zieliński et al. 2012), eight of the objects were studied also by others. These studies revealed nearly perfect agreement in effective temperatures, $\log g$ and metallicities. Three objects (HD 102272, BD+20 2457 and BD+48 738) were studied by Mortier et al. (2013) who found our atmospheric parameters to agree within 1σ with their, except [Fe/H] for BD+20 2457 that was found $\sim 3\sigma$ lower. Another five objects (HD 17092, HD 240210, HD 240237, HD 96127 and HD 219415) were studied by Sousa et al. (2015). Again, very good agreement was found in all parameters. Given various input data and methods applied, we are confident that our atmospheric parameters are robust.

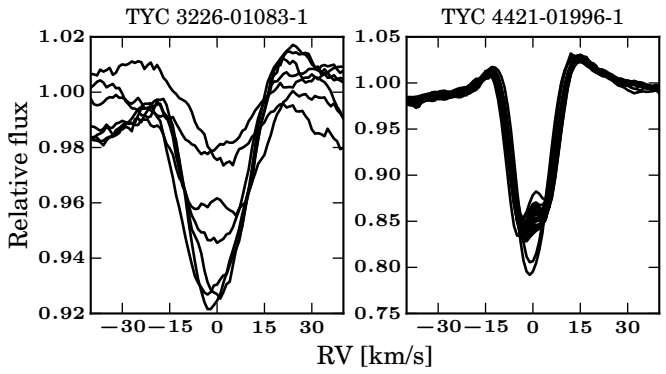

Fig. 1. CCFs for TYC 3226-01083-1 and TYC 4421-01996-1. Left panel: weak and highly variable CCF, right panel: apparently unresolved spectroscopic binary.

All available data on the program stars are summarized in Zieliński et al. (2012) where stellar masses were estimated by χ^2 fitting of stellar atmospheric parameters to Girardi et al. (2000) tracks for the nearest metallicity.

2.1. Cross-correlation function analysis

In search for the nature of the 16 stars for which spectroscopic analysis of Zieliński et al. (2012) resulted in very uncertain data, we checked the complete sample discussed here for additional components and/or variable/peculiar cross-correlation functions (CCF, Nowak 2012; Nowak et al. 2013). We found two objects which we consider multiple system due to variable CCF: TYC 0435-01209-1, TYC 4421-01996-1 (see Figure 1). We also found that TYC 3930-01790-1 and 3 out of 16 stars with incomplete data in Zieliński et al. (2012): TYC 0405-01700-1, TYC 3226-01083-1, TYC 3318-00020-1 are fast rotators with weak and variable CCF (see Figure 1), what is in good agreement with results of Adamów et al. (2014) for the last three objects. All other stars presented in Zieliński et al. (2012) show stable single CCF which makes them either single or SB1.

2.2. Atmospheric parameters

We adopted the atmospheric parameters for 327 stars from paper by Zieliński et al. (2012). Stars with variable or weak CCF identified in previous section were omitted in further analysis as their equivalent widths are very uncertain.

We also obtained atmospheric parameters for 13 stars (Table 1) from Zieliński et al. (2012), for which these authors give only rough estimates of stellar parameters although our CCF analysis revealed a steady profile. We used ARES (Sousa et al. 2007) to measure equivalent widths (EWs) for neutral (Fe I) and ionized (Fe II) iron absorption lines from the line list of Takeda et al. (2005) as most suitable for our HET/HRS spectra (Adamów et al. 2015). Next, we used the obtained EWs to determine atmospheric parameters with MOOG (Sneden 1973).

Furthermore, with the procedure identical to that described in Zieliński et al. (2012) we obtained new atmospheric parameters for TYC 3011-00791-1[1] for which a better quality spectrum was available, and for TYC 4444-00200-1, misidentified by Zieliński et al. (2012) (Table 2).

[1] The results for this star were already published in Niedzielski et al. (2015)

Table 1. Updated stellar atmospheric parameters for 13 objects from red clump PTPS sample stars.

Name TYC	[Fe/H]	$T_{\rm eff}$ [K]*	$\log g$†
0405-00684-1	−0.11± 0.14	4750	1.5
1062-00017-1	−0.07± 0.13	5000	2.0
1496-01016-1	−0.81± 0.10	4750	3.0
1496-00374-1	0.00± 0.23	4500	2.5
2818-00602-1	−0.45± 0.17	4750	1.5
2818-00990-1	−0.07± 0.12	5250	1.5
3020-01288-1	−0.17± 0.14	4500	2.0
3105-01103-1	−0.03± 0.16	4500	1.5
3226-00868-1	−0.51± 0.73	4250	3.0
3304-00479-1	−0.18± 0.12	4750	1.5
3431-00086-1	−0.27± 0.26	4750	1.5
3663-00838-1	−0.06± 0.30	5000	2.0
4006-00890-1	0.21± 0.21	4000	2.0

*All values with uncertainty 250 K

†All values with uncertainty 0.5 dex

Table 2. New stellar atmospheric parameters for 2 misidentified objects from red clump PTPS sample stars.

Name TYC	[Fe/H]	$T_{\rm eff}$ [K]	$\log g$
3011-00791-1	−0.18±0.05	4218±69	1.78±0.30
4444-00200-1	0.17±0.03	4792±60	3.27±0.18

The sample considered here contains 342 relatively bright, field stars in total, mostly giants with $T_{\rm eff}$ between 4055 K and 6239 K (G8-K2 spectral type), $\log g$ between 1.39 and 4.78 and the [Fe/H] between −1.0 to +0.45.

3. Construction of the probability distribution function

For the Bayesian analysis we adopted theoretical stellar models from Bressan et al. (2012) gathered from the interactive interface on Osservatorio Astronomico di Padova website (http:stev.oapd.inaf.itcgi-bincmd). We used isochrones with metallicity Z = 0.0001, 0.0004, 0.0008, 0.001, 0.002, 0.004, 0.006, 0.008, 0.01, 0.0152, 0.02, 0.025, 0.03, 0.04, 0.05, 0.06 and 0.008 interval in log (age/yr). The adopted solar distribution of heavy elements corresponds to Sun's metallicity: $Z \simeq 0.0152$ (Caffau et al. 2011). The helium abundance for a given metallicity was obtained from relation $Y = 0.2485 + 1.78\,Z$.

3.1. Mathematical formalism

We implemented the Bayesian method based on Jørgensen & Lindegren (2005) formalism and modified by da Silva et al. (2006) to avoid statistical biases and to take uncertainty estimates of observed quantities into consideration. For a given star, represented by full set of available atmospheric parameters (and luminosity if parallax was available): ($[{\rm Fe/H}] \pm \sigma_{[{\rm Fe/H}]}$, $\log T_{\rm eff} \pm \sigma_{\log T_{\rm eff}}$, $\log g \pm \sigma_{\log g}$, $\log L \pm \sigma_{\log L}$), isochrone of [Fe/H] and age t we calculated the probability of belonging to a given mass range.

The Initial Mass function for single star was taken from Salpeter (1955). Instead of absolute magnitude like da Silva et al.

(2006) we used luminosity (if parallax was available) and logarithm of surface gravity. We further followed the procedure detailed in da Silva et al. (2006) and calculated searched quantities (*e.g.* mass, luminosity and age) and their uncertainties from basic parameters (mean, variance) of the normalized probability distribution functions (PDFs).

For stars with Hipparcos (van Leeuwen 2007) parallaxes, for which $\pi > \sigma_\pi$, stellar luminosities were calculated directly and only stellar mass and age were obtained from PDFs.

3.2. Stellar radii

With either stellar mass or luminosity derived from the Bayesian analysis and available atmospheric parameters one can calculate stellar radii as either:

$$R/R_\odot(T_{\rm eff}, L) = \left(\frac{L}{L_\odot}\right)^{1/2} \left(\frac{T_{\rm eff\odot}}{T_{\rm eff}}\right)^2, \quad (1)$$

or

$$R/R_\odot(g, M) = \left(\frac{M}{M_\odot}\frac{g_\odot}{g}\right)^{1/2}, \quad (2)$$

where $R_\odot, M_\odot, L_\odot, T_{\rm eff\odot}$ are solar values of radius, mass, luminosity and effective temperature. We adopted the mean value of those two determinations and the total derivative as the radius uncertainty estimate.

4. Results

A typical examples of PDFs for luminosity, age and mass with apparently unique set of solutions are presented in Figure 2. In comparison with other parameters, the widest distribution and the lowest probability peak is present in the case of log (age/yr). As a consequence stellar ages obtained here are most uncertain. For 11 objects the PDF shows double peaks (see Figure 3). For such stars we estimated two separate sets of solutions, that with higher value of PDF for stellar mass is listed first. The reason for this ambiguity is higher density (degeneracy) of stellar evolutionary tracks in the part of Hertzsprung-Russell diagram occupied by many of our stars. The probability of obtaining non-unique and well separated solutions is higher for Red Giant Clump stars, common in our sample.

The resulting stellar parameters with their uncertainties are presented in Table 3, where we also present average values of radii calculated from Eq. 1 and 2.

The obtained stellar masses range between 0.88 and 3.75 solar masses with vast majority of stars (240 stars) between 1.0 and $1.5 M_\odot$. The mean uncertainty in stellar mass is $0.19 M_\odot$. For $\log L/L_\odot$ we obtained values between 0.04 and 3.1 with 164 objects with luminosities between $\log L/L_\odot$ 1.5 and 2.0. For most of stars the uncertainty in $\log L/L_\odot$ is lower than 0.3, for 288 stars with no trigonometric parallaxes the mean uncertainty in $\log L/L_\odot$ is 0.13.

Stellar ages, log (age/yr), range from 8.36 to 10.09 with mean uncertainty of ~ 0.18 dex.

The radii determined from Eq. 1 differ in most of cases from those derived from Eq. 2 by more than the estimated uncertainties. In most cases (54%) the difference is lower than 10% of the mean value, for 80% of stars it stays within 30% but uncertainties as high as 100% may happen. In Table 3 we present mean values of radii derived from both equations. The resulting radii range from 1.32 to 50.24 solar radius with mean uncertainty of 3.16 solar radius.

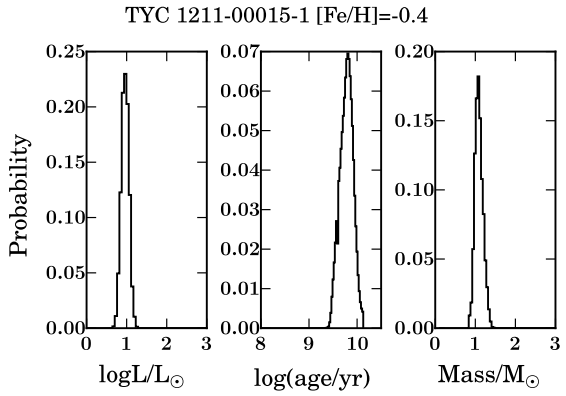

Fig. 2. Probability distribution functions for luminosity, mass and age of TYC 1211-00015-1.

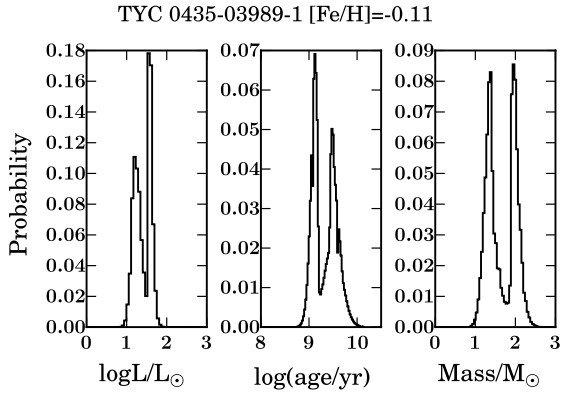

Fig. 3. Double peak probability distribution functions for luminosity, mass and age of TYC 0435-03989-1.

4.1. Comparison with Zieliński et al. (2012)

For 288 objects without trigonometric parallax, luminosities available derived by Zieliński et al. (2012) agree with ours very well with Pearsons correlation coefficient of $r = 0.80$. Our determinations are, however, more precise. Estimated uncertainties are nearly two times lower than those of Zieliński et al. (2012). As a consequence, for these stars the radii calculated from Eq. 1 are also in good agreement. Our log (age/yr) determinations are in general larger by 0.15 dex, with $r = 0.73$[2].

Stellar masses obtained here, with average value of $1.35 M_\odot$, are generally lower by over $0.1 M_\odot$ than those of Zieliński et al. (2012) - $1.5 M_\odot$, but at the same time the abundant population of stars with masses below solar is now absent. The resulting stellar masses are also more precise as the average uncertainty in Zieliński et al. (2012) is $0.28 M_\odot$. The comparison of stellar masses as well as other parameters derived here is compared with a that of Zieliński et al. (2012) in Figure 4.

4.2. Comparison with other determinations

For eight stars our stellar masses can be compared with determinations by other authors. For HD 102272, BD+20 2457 and

[2] To compare with Zieliński et al. (2012), when given range in log (age/yr), the maximum value was taken.

BD+48 740 we note good agreement with Mortier et al. (2013), well within 1σ uncertainty. Out of five stars for which stellar masses were obtained by Sousa et al. (2015) for all but one we have good agreement within 1σ as well. The only exception is HD 240237 for which our new estimated stellar mass, $1.46 \pm 0.32 M_{\odot}$ agrees within estimated uncertainties with those presented in Gettel et al. (2012) and Zieliński et al. (2012) while Sousa et al. (2015) found for this star a mass of $0.614 \pm 0.076 M_{\odot}$. We find their result rather uncertain as it is hard to believe that a star of that mass is already a giant with $\log g = 1.66 \pm 0.15$. Indeed, for the stellar mass of Sousa et al. (2015) the web interface for the Bayesian estimation of stellar parameters[3] returns $\log g = 4.662 \pm 0.358$ for this object, contrary to what these authors present.

4.3. Comparison with luminosities from trigonometric parallaxes

For 54 objects with trigonometric parallaxes we compared our Bayesian luminosities estimates (using only $\log T_{\rm eff}$, $\log g$ and [Fe/H] with their uncertainties as a stellar parameter input) with those calculated directly from trigonometric parallaxes (Figure 5) and we found a relation $\log L/L_{\odot,\pi} = (0.68 \pm 0.11) \log L/L_{\odot} + (0.72 \pm 0.18)$ and the Pearson correlation coefficient of $r = 0.66$. As expected the highest scatter is present for stars with lowest parallaxes $\pi < 5$ mas. It is obvious that the GAIA (Perryman et al. 2001) will provide parallaxes with high accuracy which will allow to determine better luminosities and in a consequence stellar masses for the stars presented here.

5. Conclusions

We presented stellar masses, luminosities and log(age/yr), obtained through a Bayesian analysis of atmospheric parameters available from Zieliński et al. (2012) as well as new estimates of radii for 342 stars, targets of the PTPS. For 13 stars we present atmospheric parameters for the first time, for another two we updated ones. The results, as based on specific set of stellar evolutionary models are obviously model - dependent. Based on results of Thompson et al. (2014) we expect, however, that in the mass range occupied by our targets this introduces inaccuracy below estimated uncertainties.

As a consequence of the adopted stellar models our stellar masses take into consideration the mass-loss at the RGB but the resulting masses represent ZAMS masses for all stars. This obvious simplification is well justified by the stellar mass range we are dealing with in our project. It is not expected that a solar-mass star loses more than $0.09 \pm 0.03 M_{\odot}$ during its evolution up to the Horizontal Branch (Miglio et al. 2012) which effect contributes only to a minor fraction of estimated uncertainties.

Presented here stellar masses represent an important improvement over previous determination due to application of much denser set of stellar models, and more detailed treatment of metallicities. As a result, significant uncertainty decrease in stellar masses was achieved. An important result is also throughout test of an improved tool to derive stellar masses from available stellar atmospheric parameters in the PTPS sample.

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[3] http://stev.oapd.inaf.it/cgi-bin/param

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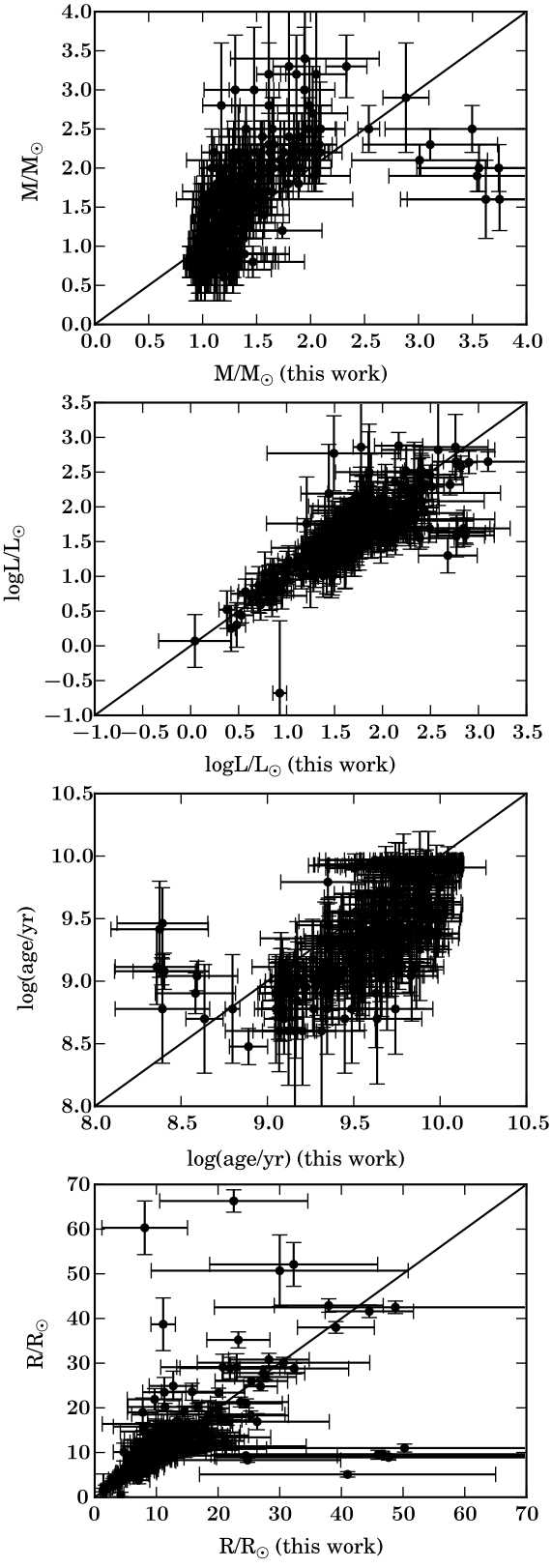

Fig. 4. Comparison of masses, luminosities, ages and radii with their uncertainties from this work and from Zieliński et al. (2012).

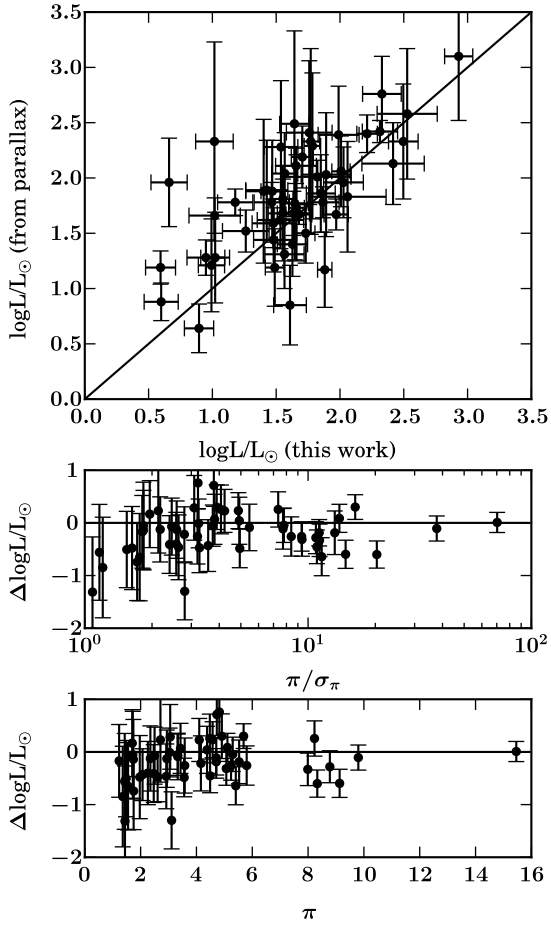

Fig. 5. Comparison of luminosities calculated from trigonometric parallaxes with our Bayesian estimates.

Table 3. Recalculated astrophysics stellar parameters for the red clump PTPS sample stars.

TYC	Names HD	BD	$M/M_\odot$	log (age/yr)	$\log L/L_\odot$	$\log L/L_{\odot,\pi}$	$R/R_\odot$
0014-00693-1	-	+04 126	1.42 ± 0.23	9.44 ± 0.21	1.78 ± 0.13	-	11.32 ± 2.14
0014-00731-1	4446	+04 118	1.32 ± 0.18	9.55 ± 0.19	1.65 ± 0.11	1.77 ± 0.51	10.45 ± 4.18
0014-00752-1	-	+04 119	1.23 ± 0.22	9.66 ± 0.24	1.74 ± 0.12	-	11.16 ± 2.10
0014-00769-1	-	+04 107	0.93 ± 0.05	10.04 ± 0.09	1.84 ± 0.05	-	12.01 ± 1.10
0014-00882-1	-	+04 112	1.21 ± 0.20	9.79 ± 0.23	1.90 ± 0.12	-	15.05 ± 2.77
0017-00572-1	-	+04 122	0.95 ± 0.06	10.04 ± 0.09	1.66 ± 0.06	1.73 ± 0.48	10.39 ± 3.92
0017-00668-1	-	-	1.11 ± 0.18	9.80 ± 0.23	1.54 ± 0.14	-	8.27 ± 1.78
0017-00900-1	-	+05 107	0.96 ± 0.07	10.02 ± 0.11	1.74 ± 0.06	-	11.07 ± 1.16
0017-01084-1	4760	+05 109	1.06 ± 0.19	9.76 ± 0.24	2.93 ± 0.11	3.10 ± 0.58	48.75 ± 29.36
0017-01136-1	-	+04 111	1.28 ± 0.20	9.57 ± 0.21	1.77 ± 0.13	-	11.37 ± 2.13
0017-01292-1	-	+04 114	1.11 ± 0.12	9.89 ± 0.16	0.53 ± 0.13	-	2.37 ± 0.50
0017-01299-1	4366	+04 113	1.07 ± 0.13	9.95 ± 0.17	1.30 ± 0.12	-	6.19 ± 1.28
0018-00446-1	-	+04 132	1.24 ± 0.15	9.66 ± 0.18	1.52 ± 0.11	-	8.45 ± 1.24
0096-00005-1	-	+06 758	1.29 ± 0.30	9.75 ± 0.28	1.95 ± 0.19	-	13.78 ± 4.72
0096-00109-1	-	+06 750	2.09 ± 0.14	9.05 ± 0.08	1.64 ± 0.06	-	8.59 ± 0.94
0096-00163-1	-	-	1.21 ± 0.20	9.75 ± 0.22	1.41 ± 0.15	-	7.47 ± 1.62
0096-00301-1	-	-	1.35 ± 0.17	9.60 ± 0.18	1.48 ± 0.13	-	8.27 ± 1.50
0096-00371-1	-	+06 755	1.17 ± 0.16	9.84 ± 0.19	1.49 ± 0.11	-	8.42 ± 1.58
0096-00378-1	-	-	1.02 ± 0.10	9.90 ± 0.15	1.57 ± 0.08	-	8.91 ± 0.97
0096-00417-1	-	-	1.57 ± 0.23	9.35 ± 0.18	1.83 ± 0.12	-	12.55 ± 2.03
0096-00418-1	-	-	1.01 ± 0.10	9.97 ± 0.14	1.52 ± 0.07	-	8.58 ± 1.05
0096-00659-1	30897	+05 751	1.41 ± 0.23	9.62 ± 0.21	0.66 ± 0.14	1.96 ± 0.40	8.81 ± 4.00
0096-00708-1	-	-	2.09 ± 0.15	9.07 ± 0.09	1.65 ± 0.08	-	8.89 ± 1.23
0096-00732-1	-	-	1.15 ± 0.09	9.74 ± 0.11	0.83 ± 0.07	-	3.38 ± 0.32
0096-00778-1	-	+06 754	1.02 ± 0.11	9.96 ± 0.15	1.33 ± 0.10	-	6.57 ± 1.03
0096-00887-1	-	-	1.17 ± 0.17	9.81 ± 0.20	1.44 ± 0.12	-	7.89 ± 1.41
0272-00909-1	-	-	1.04 ± 0.07	10.03 ± 0.09	1.42 ± 0.06	-	7.55 ± 0.89
0273-00125-1	-	+01 2626	1.10 ± 0.21	9.81 ± 0.25	2.29 ± 0.13	-	20.05 ± 4.97
0273-00150-1	-	-	1.03 ± 0.07	10.00 ± 0.10	0.64 ± 0.08	-	2.90 ± 0.35
0273-00224-1	103485	+02 2493	1.11 ± 0.21	9.79 ± 0.25	2.51 ± 0.13	-	27.37 ± 6.69
0273-00279-1	-	+02 2492	1.00 ± 0.07	10.03 ± 0.10	0.48 ± 0.09	-	2.14 ± 0.38
0273-00451-1	-	-	1.46 ± 0.23	9.36 ± 0.20	1.83 ± 0.14	-	11.56 ± 2.30
0273-00669-1	102842	+01 2619	1.40 ± 0.27	9.43 ± 0.25	1.87 ± 0.16	-	12.35 ± 2.93
0276-00507-1	-	+03 2562	1.14 ± 0.25	9.72 ± 0.28	2.70 ± 0.14	-	32.35 ± 8.82
0400-00329-1	-	-	1.40 ± 0.17	9.49 ± 0.17	1.64 ± 0.10	-	9.75 ± 1.42
0401-01176-1	-	-	1.00 ± 0.06	9.98 ± 0.09	0.87 ± 0.08	-	3.72 ± 0.44
0401-01874-1	-	+01 3439	1.42 ± 0.24	9.46 ± 0.21	1.68 ± 0.15	-	9.58 ± 1.94
0401-02049-1	157855	+01 3432	1.04 ± 0.08	10.00 ± 0.11	1.49 ± 0.07	1.19 ± 0.35	7.06 ± 1.99
0401-02075-1	-	-	1.15 ± 0.15	9.78 ± 0.18	1.62 ± 0.09	-	9.86 ± 1.40
0405-00236-1	-	+02 3328	1.14 ± 0.18	9.74 ± 0.21	1.73 ± 0.11	-	10.86 ± 1.94
0405-00405-1	-	+02 3317	1.89 ± 0.14	9.05 ± 0.09	1.96 ± 0.06	-	13.32 ± 1.22
0405-00414-1	-	-	1.03 ± 0.13	9.93 ± 0.18	1.45 ± 0.12	-	7.31 ± 1.37
0405-00510-1	-	+03 3401	1.17 ± 0.16	9.76 ± 0.20	1.60 ± 0.11	-	9.49 ± 1.65
0405-00581-1	-	+02 3322	1.13 ± 0.12	9.90 ± 0.15	1.49 ± 0.08	-	8.93 ± 1.13
0405-00684-1	-	+02 3308	3.74 ± 0.76	8.36 ± 0.24	2.78 ± 0.29	-	46.65 ± 27.24
0405-01114-1	-	+02 3313	1.11 ± 0.13	9.95 ± 0.17	1.54 ± 0.11	-	9.17 ± 1.69
0405-01633-1	157936A	+02 3314A	1.02 ± 0.11	9.96 ± 0.15	1.71 ± 0.08	-	10.69 ± 1.58
0405-01634-1	-	-	1.39 ± 0.16	9.50 ± 0.15	1.59 ± 0.10	-	9.16 ± 1.32
0405-01855-1	158253	+02 3321	1.20 ± 0.24	9.74 ± 0.26	2.34 ± 0.13	-	25.40 ± 5.88
0418-00640-1	-	-	0.88 ± 0.03	10.08 ± 0.05	2.30 ± 0.05	-	20.10 ± 1.71
0418-00912-1	-	+02 3332	1.21 ± 0.17	9.68 ± 0.20	1.57 ± 0.12	-	8.87 ± 1.40
0430-00356-1	-	+01 3567	1.38 ± 0.19	9.57 ± 0.19	1.60 ± 0.11	-	9.70 ± 1.70
0430-02902-1	165592	+01 3593	1.52 ± 0.25	9.37 ± 0.20	1.70 ± 0.16	-	9.52 ± 1.95
0434-00031-1	-	+02 3465	1.08 ± 0.13	9.93 ± 0.17	1.59 ± 0.11	-	9.87 ± 1.64
0434-00551-1	-	-	1.39 ± 0.26	9.53 ± 0.24	1.77 ± 0.08	-	10.97 ± 1.65
0434-00632-1	164734	+03 3572	1.99 ± 0.21	9.10 ± 0.11	1.73 ± 0.07	1.50 ± 0.27	8.40 ± 1.92
0434-00756-1	-	+03 3584	1.84 ± 0.18	9.21 ± 0.11	1.61 ± 0.12	-	8.54 ± 1.43
0434-01143-1	-	-	1.61 ± 0.19	9.36 ± 0.14	1.72 ± 0.09	-	10.31 ± 1.44
0434-01505-1	-	+03 3590	1.22 ± 0.13	9.67 ± 0.16	1.63 ± 0.08	-	9.73 ± 1.09

Table 3. continued.

TYC	Names HD	BD	$M/M_\odot$	log (age/yr)	$\log L/L_\odot$	$\log L/L_{\odot,\pi}$	$R/R_\odot$
0434-03595-1	165574	+02 3489	1.27 ± 0.29	9.69 ± 0.29	1.76 ± 0.18	2.41 ± 0.65	18.43 ± 12.43
0434-03897-1	-	-	1.22 ± 0.18	9.69 ± 0.22	1.54 ± 0.13	-	8.67 ± 1.62
0434-04234-1	165742	+02 3493	1.12 ± 0.15	9.83 ± 0.19	2.21 ± 0.08	2.40 ± 0.17	23.29 ± 5.12
0434-04538-1	-	-	1.04 ± 0.14	9.88 ± 0.19	1.67 ± 0.09	-	9.99 ± 1.60
0434-04779-1	165419	+01 3585	1.12 ± 0.16	9.89 ± 0.20	1.78 ± 0.10	-	12.27 ± 2.25
0435-03332-1	-	+02 3497	1.81 ± 0.24	9.22 ± 0.17	1.47 ± 0.15	-	7.08 ± 1.23
0683-00667-1	-	+07 735	1.61 ± 0.11	9.31 ± 0.08	1.80 ± 0.03	-	11.16 ± 1.04
0683-00789-1	-	+07 721	1.36 ± 0.20	9.53 ± 0.20	1.67 ± 0.12	-	10.10 ± 1.83
0683-01063-1	-	-	1.25 ± 0.05	9.31 ± 0.13	0.38 ± 0.08	-	1.32 ± 0.21
0683-01190-1	-	+07 736	1.09 ± 0.11	9.86 ± 0.16	1.65 ± 0.10	-	10.64 ± 2.32
0684-00553-1	-	-	1.61 ± 0.34	9.35 ± 0.29	1.90 ± 0.14	-	13.42 ± 2.57
0684-00744-1	-	+07 742	1.24 ± 0.26	9.75 ± 0.26	2.10 ± 0.15	-	18.56 ± 4.85
0684-01276-1	-	-	1.30 ± 0.15	9.66 ± 0.17	1.50 ± 0.10	-	8.58 ± 1.24
0863-00082-1	-	+15 2372	1.26 ± 0.19	9.63 ± 0.21	1.30 ± 0.15	-	6.29 ± 1.39
0863-00230-1	-	+15 2371	1.35 ± 0.25	9.63 ± 0.24	1.37 ± 0.21	-	7.13 ± 1.99
0870-00084-1	-	-	1.06 ± 0.14	9.88 ± 0.19	0.82 ± 0.18	-	3.26 ± 0.99
0870-00114-1	102272	+14 2434	1.01 ± 0.12	9.91 ± 0.17	1.63 ± 0.12	1.40 ± 0.29	8.02 ± 2.14
0870-00130-1	-	+15 2387	0.99 ± 0.09	9.94 ± 0.14	0.99 ± 0.10	1.21 ± 0.42	4.73 ± 1.71
0870-00204-1	-	+15 2375	1.08 ± 0.14	9.87 ± 0.18	1.57 ± 0.10	-	8.95 ± 1.47
0870-00207-1	-	+15 2386	1.01 ± 0.16	9.88 ± 0.21	2.22 ± 0.11	-	17.22 ± 3.59
0870-00241-1	102103	+15 2374	1.56 ± 0.28	9.42 ± 0.22	1.82 ± 0.26	2.01 ± 0.15	14.52 ± 4.61
0870-00255-1	-	+15 2390	1.13 ± 0.16	9.85 ± 0.19	0.99 ± 0.16	-	4.36 ± 1.15
0870-00314-1	-	-	1.13 ± 0.15	9.88 ± 0.19	1.01 ± 0.17	-	4.47 ± 1.25
0870-00937-1	-	+15 2385	1.26 ± 0.22	9.71 ± 0.23	1.27 ± 0.18	-	6.31 ± 1.63
0955-00126-1	-	-	0.98 ± 0.06	10.00 ± 0.09	0.70 ± 0.10	-	2.99 ± 0.44
0956-00028-1	-	+14 2970	0.97 ± 0.15	9.88 ± 0.20	2.90 ± 0.09	-	44.52 ± 7.16
1058-00120-1	188105	+07 4275	1.17 ± 0.19	9.78 ± 0.21	1.63 ± 0.13	1.68 ± 0.20	10.43 ± 2.62
1058-00205-1	188369	+08 4263	1.20 ± 0.18	9.76 ± 0.21	1.48 ± 0.16	1.44 ± 0.29	7.79 ± 2.48
1058-00635-1	188004	+08 4249	1.31 ± 0.23	9.57 ± 0.24	1.69 ± 0.15	-	10.10 ± 2.25
1058-00979-1	-	+08 4223	1.19 ± 0.19	9.82 ± 0.22	1.38 ± 0.18	-	6.73 ± 2.04
1058-01279-1	188237	+08 4259	1.36 ± 0.17	9.51 ± 0.18	1.70 ± 0.10	-	10.45 ± 1.52
1058-01537-1	187377	+08 4228	1.35 ± 0.26	9.55 ± 0.25	1.61 ± 0.20	-	8.77 ± 2.43
1058-01931-1	-	-	2.54 ± 0.10	8.80 ± 0.04	1.72 ± 0.06	-	9.20 ± 0.73
1058-02389-1	188124	+08 4252	1.37 ± 0.16	9.56 ± 0.14	1.58 ± 0.13	-	8.72 ± 1.85
1058-02865-1	188214	+08 4258	1.00 ± 0.10	9.99 ± 0.13	1.20 ± 0.10	-	5.45 ± 0.94
1058-02919-1	-	-	1.37 ± 0.22	9.51 ± 0.21	1.46 ± 0.15	-	7.55 ± 1.54
1058-02972-1	187094	+07 4230	1.21 ± 0.22	9.72 ± 0.24	1.67 ± 0.13	-	10.38 ± 2.23
1058-03032-1	187526	+08 4230	1.85 ± 0.18	9.14 ± 0.10	1.36 ± 0.10	-	6.14 ± 0.86
1058-03402-1	-	+08 4232	1.23 ± 0.16	9.78 ± 0.20	1.43 ± 0.11	-	8.00 ± 1.39
1062-00017-1	187552	+09 4280	3.11 ± 0.62	8.58 ± 0.23	2.35 ± 0.35	-	24.51 ± 14.82
1208-00063-1	-	-	1.02 ± 0.13	9.91 ± 0.18	1.58 ± 0.10	-	8.71 ± 1.43
1208-00261-1	10364	+19 277	1.37 ± 0.16	9.60 ± 0.17	1.48 ± 0.17	1.59 ± 0.22	8.91 ± 2.41
1208-00623-1	-	+18 219	1.13 ± 0.17	9.87 ± 0.21	2.14 ± 0.12	-	18.17 ± 3.96
1211-00015-1	-	-	1.09 ± 0.10	9.78 ± 0.14	0.96 ± 0.09	-	3.91 ± 0.52
1211-00016-1	-	-	0.98 ± 0.08	10.02 ± 0.11	1.27 ± 0.07	-	5.97 ± 0.80
1211-00103-1	-	-	1.05 ± 0.14	9.93 ± 0.18	1.48 ± 0.08	-	8.18 ± 1.11
1211-00153-1	-	-	1.83 ± 0.14	9.21 ± 0.07	1.67 ± 0.08	-	9.12 ± 1.27
1211-00335-1	-	+19 271	1.06 ± 0.15	9.90 ± 0.20	2.13 ± 0.10	-	17.43 ± 3.34
1211-00406-1	-	-	1.75 ± 0.16	9.26 ± 0.11	1.65 ± 0.12	-	9.06 ± 1.50
1211-00449-1	-	-	1.27 ± 0.09	9.65 ± 0.11	0.71 ± 0.07	-	3.01 ± 0.35
1211-00603-1	-	+20 274	1.02 ± 0.14	9.91 ± 0.19	2.24 ± 0.09	-	20.38 ± 3.48
1211-00677-1	-	-	1.07 ± 0.15	9.89 ± 0.19	1.96 ± 0.10	-	15.36 ± 2.51
1422-00100-1	-	+20 2454	1.17 ± 0.14	9.89 ± 0.18	1.31 ± 0.12	-	6.87 ± 1.31
1422-00614-1	-	-	1.16 ± 0.18	9.77 ± 0.22	1.36 ± 0.16	-	6.80 ± 1.66
1422-00790-1	-	+20 2457	0.96 ± 0.14	9.90 ± 0.19	2.81 ± 0.08	-	39.10 ± 6.23
1422-01044-1	-	-	1.27 ± 0.33	9.70 ± 0.30	2.17 ± 0.18	-	18.94 ± 6.00
1423-00013-1	-	-	1.26 ± 0.31	9.72 ± 0.29	2.08 ± 0.17	-	16.96 ± 5.32
1423-00156-1	-	-	1.06 ± 0.13	9.95 ± 0.16	1.92 ± 0.09	-	14.53 ± 2.21
1423-00165-1	-	+20 2464	1.04 ± 0.07	10.03 ± 0.10	1.65 ± 0.06	-	10.06 ± 1.25
1423-00248-1	-	-	1.22 ± 0.23	9.80 ± 0.25	1.76 ± 0.16	-	11.34 ± 3.15

Table 3. continued.

TYC	Names HD	BD	$M/M_\odot$	log (age/yr)	$\log L/L_\odot$	$\log L/L_{\odot,\pi}$	$R/R_\odot$
1423-00364-1	-	-	1.11 ± 0.18	9.84 ± 0.22	1.61 ± 0.13	-	9.07 ± 2.15
1423-00457-1	89930	+19 2335	1.54 ± 0.19	9.37 ± 0.14	1.47 ± 0.14	1.78 ± 0.18	9.89 ± 2.08
1425-01506-1	89196	+20 2460	1.33 ± 0.47	9.64 ± 0.35	2.42 ± 0.22	-	23.02 ± 9.73
1426-00662-1	-	+21 2173	1.05 ± 0.10	9.97 ± 0.14	1.47 ± 0.09	-	7.48 ± 1.32
1426-00810-1	89772	+20 2475	1.32 ± 0.36	9.62 ± 0.32	2.10 ± 0.18	-	18.14 ± 5.47
1426-01004-1	-	-	1.99 ± 0.06	9.11 ± 0.05	1.58 ± 0.04	-	8.03 ± 0.66
1426-01209-1	89471	+21 2175	1.36 ± 0.30	9.63 ± 0.28	1.99 ± 0.16	2.39 ± 0.44	20.78 ± 10.07
1496-00050-1	-	-	1.55 ± 0.40	9.27 ± 0.32	1.88 ± 0.19	-	11.00 ± 2.98
1496-00290-1	-	-	1.07 ± 0.17	9.87 ± 0.21	1.69 ± 0.13	-	10.21 ± 2.28
1496-00374-1	-	+15 2932	1.40 ± 0.31	9.60 ± 0.28	1.71 ± 0.23	-	11.39 ± 5.99
1496-00572-1	143257	+16 2855	1.20 ± 0.17	9.82 ± 0.20	1.70 ± 0.09	2.19 ± 0.28	15.79 ± 4.95
1496-00637-1	143064	+16 2851	1.38 ± 0.21	9.64 ± 0.20	1.43 ± 0.17	1.89 ± 0.45	10.94 ± 5.07
1496-00840-1	-	+16 2852	1.34 ± 0.19	9.51 ± 0.20	1.72 ± 0.12	-	10.47 ± 1.90
1496-00961-1	-	-	1.06 ± 0.11	9.88 ± 0.15	0.85 ± 0.11	-	3.53 ± 0.58
1496-01002-1	-	-	0.97 ± 0.12	9.84 ± 0.42	0.04 ± 0.38	-	1.41 ± 0.51
1496-01016-1	-	+16 2854	1.19 ± 0.38	9.63 ± 0.36	1.66 ± 0.38	-	7.84 ± 4.82
1496-01656-1	-	-	0.95 ± 0.08	10.00 ± 0.12	2.40 ± 0.05	-	26.89 ± 2.73
1496-01841-1	142245	+15 2925	1.42 ± 0.10	9.54 ± 0.08	0.59 ± 0.12	1.19 ± 0.15	4.18 ± 0.82
1503-01050-1	-	+15 2940	1.17 ± 0.18	9.74 ± 0.22	1.40 ± 0.14	1.88 ± 0.65	9.87 ± 5.71
2818-00449-1	-	+39 373	1.12 ± 0.12	9.92 ± 0.15	1.02 ± 0.11	1.28 ± 0.41	5.57 ± 2.12
2818-00504-1	-	+40 334	1.05 ± 0.18	9.84 ± 0.23	2.50 ± 0.12	2.33 ± 0.52	26.34 ± 11.70
2818-00602-1	-	-	3.50 ± 0.81	8.39 ± 0.27	2.87 ± 0.29	-	47.65 ± 27.90
2818-00733-1	-	+40 317	1.17 ± 0.18	9.82 ± 0.21	1.57 ± 0.10	2.04 ± 0.37	13.38 ± 4.79
2818-00874-1	-	+40 338	0.98 ± 0.08	10.00 ± 0.12	1.36 ± 0.07	-	6.88 ± 0.81
2818-00990-1	-	-	3.56 ± 0.54	8.40 ± 0.18	2.68 ± 0.31	-	41.00 ± 24.01
2818-01153-1	-	+40 321	1.13 ± 0.21	9.79 ± 0.25	2.39 ± 0.13	-	24.59 ± 5.83
2818-02188-1	9712	+40 328	1.60 ± 0.20	9.35 ± 0.14	1.18 ± 0.14	1.78 ± 0.12	8.84 ± 1.76
2822-00208-1	-	-	1.42 ± 0.19	9.54 ± 0.18	1.51 ± 0.14	-	8.57 ± 1.63
2822-00410-1	9416	+41 300	1.87 ± 0.22	9.16 ± 0.12	1.78 ± 0.06	2.29 ± 0.66	14.70 ± 8.02
2822-01573-1	-	+41 306	2.33 ± 0.19	8.89 ± 0.11	1.86 ± 0.09	-	11.03 ± 1.42
2822-01643-1	9519	+41 304	1.13 ± 0.19	9.85 ± 0.22	1.98 ± 0.13	-	14.61 ± 3.41
2822-02010-1	-	-	1.24 ± 0.09	9.75 ± 0.11	0.82 ± 0.08	-	3.65 ± 0.44
2823-01028-1	-	+40 351	0.88 ± 0.04	10.07 ± 0.06	1.88 ± 0.06	1.17 ± 0.34	7.67 ± 1.97
2823-01398-1	-	+40 348	0.96 ± 0.09	9.99 ± 0.13	1.36 ± 0.08	-	6.51 ± 0.94
2823-01786-1	10455	+40 352	1.79 ± 0.24	9.26 ± 0.16	1.58 ± 0.16	-	8.58 ± 1.72
3011-00547-1	-	+44 2037	1.04 ± 0.08	10.00 ± 0.11	0.88 ± 0.10	-	3.93 ± 0.58
3011-00791-1	95127	+44 2038	1.74 ± 0.37	9.35 ± 0.27	2.42 ± 0.24	2.13 ± 0.37	9.71 ± 4.44
3012-00126-1	-	+44 2059	1.29 ± 0.21	9.53 ± 0.22	1.72 ± 0.14	-	10.07 ± 1.97
3012-00145-1	96992	+44 2063	0.99 ± 0.11	9.96 ± 0.16	1.47 ± 0.09	1.88 ± 0.46	9.92 ± 4.19
3012-00273-1	-	+44 2057	0.88 ± 0.03	10.09 ± 0.05	0.42 ± 0.04	-	1.74 ± 0.18
3012-00285-1	-	+44 2047	1.17 ± 0.17	9.89 ± 0.20	1.47 ± 0.14	-	7.91 ± 2.15
3012-00470-1	-	-	1.07 ± 0.12	9.88 ± 0.17	0.96 ± 0.13	-	4.09 ± 0.81
3012-00667-1	96127	+45 1892	1.39 ± 0.29	9.54 ± 0.27	2.33 ± 0.15	2.76 ± 0.34	32.26 ± 13.62
3012-00676-1	-	+44 2041	1.11 ± 0.15	9.88 ± 0.19	1.24 ± 0.14	-	5.96 ± 1.34
3012-01263-1	-	-	1.16 ± 0.20	9.76 ± 0.24	2.17 ± 0.12	-	20.71 ± 3.85
3012-01504-1	-	+43 2070	1.00 ± 0.05	10.05 ± 0.08	0.90 ± 0.11	0.64 ± 0.22	3.37 ± 0.78
3012-01520-1	-	+43 2080	1.31 ± 0.39	9.67 ± 0.32	2.25 ± 0.19	-	21.09 ± 7.44
3012-02518-1	95296	+43 2069	2.03 ± 0.33	9.11 ± 0.20	1.66 ± 0.16	2.11 ± 0.16	15.02 ± 3.84
3012-02527-1	-	+44 2046	1.10 ± 0.11	9.92 ± 0.15	0.69 ± 0.12	-	3.10 ± 0.59
3018-00288-1	-	+41 2310	0.98 ± 0.09	9.99 ± 0.13	1.61 ± 0.08	-	8.90 ± 1.37
3018-00336-1	-	+41 2304	1.18 ± 0.18	9.86 ± 0.21	1.48 ± 0.14	-	7.83 ± 2.12
3018-00350-1	108872	+41 2298	1.23 ± 0.17	9.74 ± 0.20	1.57 ± 0.15	1.31 ± 0.31	7.78 ± 2.50
3018-00704-1	109461	+41 2305	1.51 ± 0.36	9.36 ± 0.28	1.89 ± 0.20	2.03 ± 0.56	13.79 ± 6.96
3018-00708-1	110065	+41 2313	1.44 ± 0.11	9.53 ± 0.08	0.60 ± 0.13	0.88 ± 0.17	3.25 ± 0.68
3018-00996-1	109681	+41 2308	1.27 ± 0.13	9.73 ± 0.15	0.95 ± 0.15	1.28 ± 0.16	5.41 ± 1.30
3018-01050-1	109740	+41 2309	1.12 ± 0.17	9.86 ± 0.20	1.55 ± 0.11	1.68 ± 0.43	9.46 ± 3.97
3020-01183-1	-	+42 2322	1.07 ± 0.09	9.99 ± 0.12	1.61 ± 0.13	0.85 ± 0.36	7.10 ± 1.83
3020-01288-1	-	+42 2315	1.38 ± 0.30	9.56 ± 0.29	1.99 ± 0.26	-	17.85 ± 10.01
3020-02438-1	-	+42 2320	1.28 ± 0.17	9.61 ± 0.18	1.48 ± 0.11	-	8.00 ± 1.21
3105-00228-1	-	+39 3457	1.14 ± 0.21	9.71 ± 0.26	1.77 ± 0.15	-	10.60 ± 2.55

Table 3. continued.

TYC	Names HD	BD	$M/M_\odot$	$\log(\mathrm{age/yr})$	$\log L/L_\odot$	$\log L/L_{\odot,\pi}$	$R/R_\odot$
3105-00535-1	-	+38 3228	1.31 ± 0.18	9.67 ± 0.19	1.51 ± 0.12	-	8.92 ± 1.56
3105-00683-1	-	+38 3201	0.98 ± 0.08	10.02 ± 0.11	1.12 ± 0.08	-	5.01 ± 0.71
3105-00692-1	-	-	1.21 ± 0.29	9.65 ± 0.29	2.19 ± 0.14	-	20.08 ± 4.25
3105-00873-1	-	-	1.13 ± 0.19	9.82 ± 0.23	2.00 ± 0.11	-	16.67 ± 2.98
3105-01095-1	-	+37 3182	1.93 ± 0.21	9.17 ± 0.11	1.73 ± 0.08	-	9.97 ± 1.45
3105-01103-1	-	+37 3172	3.75 ± 0.86	8.38 ± 0.28	2.84 ± 0.28	-	50.24 ± 28.97
3105-01137-1	-	+38 3205	0.97 ± 0.08	10.02 ± 0.11	1.50 ± 0.09	-	6.89 ± 1.16
3105-01851-1	-	+37 3198	1.45 ± 0.35	9.48 ± 0.30	1.81 ± 0.16	-	11.96 ± 2.96
3105-01862-1	-	-	1.48 ± 0.23	9.45 ± 0.17	1.80 ± 0.06	-	11.28 ± 1.47
3105-02077-1	-	+38 3235	0.94 ± 0.03	10.08 ± 0.05	1.25 ± 0.04	-	5.74 ± 0.50
3109-00661-1	-	+39 3464	1.13 ± 0.12	9.86 ± 0.15	0.98 ± 0.09	-	4.42 ± 0.60
3109-01946-1	-	-	0.99 ± 0.12	9.95 ± 0.16	1.46 ± 0.10	-	7.41 ± 1.19
3109-02342-1	-	+39 3480	1.09 ± 0.17	9.83 ± 0.22	1.55 ± 0.12	-	8.49 ± 1.56
3118-00440-1	-	+39 3493	2.02 ± 0.32	9.10 ± 0.17	1.76 ± 0.12	-	10.06 ± 2.05
3118-02068-1	-	+38 3258	1.16 ± 0.16	9.89 ± 0.19	1.48 ± 0.11	-	8.88 ± 1.70
3226-00556-1	215443	+43 4293	1.94 ± 0.28	9.12 ± 0.15	1.82 ± 0.10	-	10.86 ± 1.83
3226-00696-1	-	+43 4303	1.16 ± 0.18	9.85 ± 0.22	1.70 ± 0.12	-	11.10 ± 2.21
3226-00868-1	215040	+43 4270	1.28 ± 0.43	9.64 ± 0.38	1.49 ± 0.70	-	8.11 ± 6.94
3226-00993-1	215472	+43 4295	1.57 ± 0.22	9.40 ± 0.18	1.52 ± 0.13	-	8.37 ± 1.40
3226-00997-1	215335	+43 4288	1.30 ± 0.18	9.67 ± 0.19	1.55 ± 0.10	1.81 ± 0.18	11.45 ± 2.45
3226-01219-1	216016	+43 4310	1.54 ± 0.23	9.35 ± 0.18	1.77 ± 0.10	-	10.31 ± 1.59
3226-01373-1	215576	+43 4299	1.28 ± 0.23	9.69 ± 0.24	1.35 ± 0.19	-	6.98 ± 1.86
3226-01589-1	-	-	1.08 ± 0.13	9.88 ± 0.17	1.21 ± 0.09	-	5.78 ± 0.82
3226-01858-1	216161	+42 4506	1.14 ± 0.13	9.88 ± 0.17	1.13 ± 0.11	-	5.46 ± 0.90
3226-02051-1	215346	+43 4289	1.08 ± 0.12	9.95 ± 0.16	1.88 ± 0.08	-	14.10 ± 2.05
3226-02100-1	215897	+42 4501	1.40 ± 0.20	9.53 ± 0.18	1.28 ± 0.11	-	6.29 ± 0.97
3226-02285-1	214868	+43 4266	1.38 ± 0.17	9.51 ± 0.17	2.31 ± 0.14	2.42 ± 0.10	27.70 ± 5.00
3227-00068-1	216307	+42 4517	1.66 ± 0.29	9.34 ± 0.20	1.73 ± 0.12	-	10.20 ± 2.12
3227-00213-1	216257	+44 4251	1.01 ± 0.10	9.98 ± 0.14	2.01 ± 0.07	2.06 ± 0.32	16.41 ± 4.95
3300-00133-1	-	-	2.04 ± 0.16	9.08 ± 0.10	1.41 ± 0.10	-	6.76 ± 0.92
3300-01380-1	-	+47 678	2.05 ± 0.15	9.08 ± 0.09	1.62 ± 0.08	-	8.09 ± 1.26
3300-01645-1	-	+47 682	1.25 ± 0.28	9.72 ± 0.28	2.00 ± 0.16	-	16.37 ± 4.19
3300-01952-1	-	+48 749	1.45 ± 0.27	9.52 ± 0.24	1.57 ± 0.21	-	8.73 ± 2.43
3304-00088-1	-	-	1.66 ± 0.26	9.28 ± 0.18	1.77 ± 0.12	-	10.09 ± 2.03
3304-00090-1	-	+48 740	1.12 ± 0.18	9.87 ± 0.21	1.64 ± 0.12	2.49 ± 0.84	19.27 ± 15.02
3304-00101-1	17092	+49 767	1.25 ± 0.17	9.73 ± 0.19	1.57 ± 0.09	-	9.68 ± 1.40
3304-00110-1	-	+48 725	1.21 ± 0.22	9.80 ± 0.24	2.08 ± 0.13	-	18.48 ± 4.16
3304-00323-1	-	+48 738	1.16 ± 0.22	9.79 ± 0.25	1.97 ± 0.14	-	14.97 ± 3.50
3304-00405-1	-	+49 775	1.47 ± 0.48	9.60 ± 0.36	2.06 ± 0.23	-	17.26 ± 6.97
3304-00408-1	17028	+48 750	1.35 ± 0.41	9.59 ± 0.32	2.53 ± 0.24	2.58 ± 0.59	30.00 ± 20.83
3304-00479-1	16992	+49 758	3.62 ± 0.79	8.39 ± 0.26	2.77 ± 0.29	-	45.95 ± 27.10
3304-00553-1	-	-	1.31 ± 0.34	9.70 ± 0.30	2.08 ± 0.18	-	17.28 ± 5.61
3304-01910-1	-	+49 772	1.23 ± 0.27	9.73 ± 0.28	1.90 ± 0.16	-	14.12 ± 3.59
3314-01371-1	-	-	1.30 ± 0.16	9.59 ± 0.15	1.02 ± 0.11	-	4.39 ± 0.75
3318-00789-1	-	+49 835	1.00 ± 0.12	9.94 ± 0.17	1.44 ± 0.11	-	7.02 ± 1.31
3318-01302-1	-	+49 852	1.95 ± 0.69	9.16 ± 0.40	2.25 ± 0.26	-	21.93 ± 8.10
3318-01333-1	-	-	1.19 ± 0.14	9.78 ± 0.18	1.21 ± 0.11	-	5.90 ± 1.00
3318-01427-1	-	-	1.54 ± 0.21	9.41 ± 0.16	1.68 ± 0.11	-	9.96 ± 1.54
3318-01487-1	-	+49 859	1.72 ± 0.24	9.29 ± 0.17	1.63 ± 0.16	-	8.87 ± 1.76
3318-01515-1	-	+49 828	1.52 ± 0.22	9.37 ± 0.18	1.47 ± 0.13	-	7.55 ± 1.28
3318-01538-1	18927	+49 838	1.98 ± 0.34	9.13 ± 0.19	1.74 ± 0.14	-	9.97 ± 2.16
3319-00170-1	-	-	1.09 ± 0.15	9.86 ± 0.20	1.46 ± 0.12	-	7.81 ± 1.38
3319-00172-1	-	+49 872	1.57 ± 0.82	9.44 ± 0.48	2.49 ± 0.27	-	30.62 ± 13.98
3319-00366-1	19636	+48 859	1.36 ± 0.24	9.54 ± 0.23	1.59 ± 0.18	-	8.82 ± 2.14
3430-00053-1	-	-	0.97 ± 0.09	9.98 ± 0.13	1.18 ± 0.09	-	5.17 ± 0.79
3430-00480-1	-	+52 1375	1.00 ± 0.12	9.93 ± 0.16	1.67 ± 0.09	-	9.61 ± 1.64
3430-00683-1	-	-	0.94 ± 0.08	10.01 ± 0.12	1.58 ± 0.09	-	8.27 ± 1.20
3430-00747-1	233601	+53 1310	1.13 ± 0.21	9.80 ± 0.25	2.44 ± 0.13	-	25.30 ± 6.12
3431-00086-1	-	-	3.54 ± 0.82	8.39 ± 0.27	2.86 ± 0.30	-	47.62 ± 28.17
3431-00680-1	-	-	1.36 ± 0.26	9.54 ± 0.25	1.72 ± 0.14	-	10.37 ± 2.30

Table 3. continued.

TYC	Names HD	BD	$M/M_\odot$	log (age/yr)	$\log L/L_\odot$	$\log L/L_{\odot,\pi}$	$R/R_\odot$
3621-00326-1	215909	+44 4234	1.22 ± 0.21	9.76 ± 0.23	2.03 ± 0.16	1.96 ± 0.32	16.35 ± 5.61
3621-00445-1	-	+44 4237	1.26 ± 0.18	9.76 ± 0.20	1.50 ± 0.12	-	8.88 ± 1.79
3621-00792-1	215150	+44 4203	1.12 ± 0.17	9.86 ± 0.20	1.17 ± 0.18	-	5.30 ± 1.54
3663-00024-1	-	-	1.11 ± 0.14	9.91 ± 0.18	1.54 ± 0.09	-	9.42 ± 1.52
3663-00578-1	-	-	1.47 ± 0.13	9.33 ± 0.11	1.83 ± 0.07	-	11.44 ± 1.12
3663-00622-1	236545	+56 135	1.80 ± 0.26	9.23 ± 0.15	1.77 ± 0.07	2.33 ± 0.84	15.44 ± 10.87
3663-00654-1	-	-	1.03 ± 0.12	9.93 ± 0.16	1.59 ± 0.08	-	9.15 ± 1.38
3663-00789-1	236525	+56 127	1.95 ± 0.22	9.17 ± 0.12	1.67 ± 0.10	-	9.26 ± 1.50
3663-00838-1	236555	+56 138	3.01 ± 0.63	8.59 ± 0.24	2.39 ± 0.36	-	24.78 ± 15.11
3663-01007-1	236559	+56 140	1.05 ± 0.10	9.98 ± 0.14	1.42 ± 0.09	-	7.52 ± 1.10
3663-01040-1	236565	+56 142	1.34 ± 0.18	9.56 ± 0.19	1.54 ± 0.13	2.28 ± 0.60	14.62 ± 8.08
3663-01463-1	-	+55 182	0.92 ± 0.08	10.00 ± 0.13	1.64 ± 0.08	-	8.32 ± 1.29
3663-01888-1	-	-	1.05 ± 0.13	9.90 ± 0.18	1.85 ± 0.09	-	13.32 ± 1.80
3663-01966-1	-	-	2.88 ± 0.21	8.64 ± 0.11	2.26 ± 0.09	-	17.66 ± 2.28
3663-01992-1	-	-	1.20 ± 0.10	9.69 ± 0.12	0.85 ± 0.10	-	3.51 ± 0.55
3663-02054-1	-	-	1.09 ± 0.15	9.86 ± 0.20	1.52 ± 0.12	-	8.22 ± 1.62
3663-02059-1	-	+56 139A	1.62 ± 0.20	9.37 ± 0.14	1.74 ± 0.08	-	10.51 ± 1.56
3663-02434-1	236543	+56 134	1.17 ± 0.17	9.74 ± 0.22	2.06 ± 0.30	1.83 ± 0.50	13.21 ± 5.85
3667-00262-1	236563	+57 163	1.61 ± 0.26	9.31 ± 0.18	1.83 ± 0.06	-	11.06 ± 1.47
3667-00512-1	236530	+57 146	1.10 ± 0.17	9.86 ± 0.20	1.53 ± 0.12	-	8.19 ± 1.77
3667-00550-1	-	-	1.79 ± 0.18	9.18 ± 0.13	1.55 ± 0.11	-	7.70 ± 1.12
3667-01178-1	3933	+57 130	2.05 ± 0.28	9.07 ± 0.15	1.85 ± 0.11	1.86 ± 0.35	11.28 ± 3.50
3667-01280-1	-	-	1.87 ± 0.17	9.13 ± 0.10	1.38 ± 0.10	-	6.26 ± 0.86
3667-01442-1	-	-	1.92 ± 0.16	9.17 ± 0.09	1.70 ± 0.07	-	9.56 ± 1.11
3667-01636-1	-	+57 144	1.40 ± 0.23	9.49 ± 0.19	1.02 ± 0.15	2.33 ± 0.90	11.79 ± 10.57
3667-01656-1	236562	+57 162	1.41 ± 0.23	9.55 ± 0.22	1.40 ± 0.19	-	7.36 ± 1.83
3676-02387-1	-	-	1.35 ± 0.22	9.57 ± 0.20	0.77 ± 0.20	-	3.19 ± 0.94
3805-00193-1	233604	+54 1280	1.24 ± 0.14	9.62 ± 0.16	1.66 ± 0.09	-	9.81 ± 1.14
3805-01162-1	-	-	1.07 ± 0.09	9.99 ± 0.13	0.95 ± 0.12	-	4.18 ± 0.86
3806-00244-1	-	-	1.03 ± 0.12	9.91 ± 0.16	1.37 ± 0.09	-	6.95 ± 0.96
3806-00861-1	-	-	1.00 ± 0.11	9.92 ± 0.16	1.61 ± 0.09	-	9.30 ± 1.24
3806-01026-1	-	-	0.98 ± 0.03	10.08 ± 0.05	0.87 ± 0.05	-	3.83 ± 0.36
3806-01071-1	233612	+53 1318	1.07 ± 0.20	9.79 ± 0.25	2.77 ± 0.13	-	37.95 ± 8.83
3806-01289-1	233615	+53 1324	1.09 ± 0.18	9.85 ± 0.23	2.35 ± 0.12	-	21.43 ± 4.96
3917-01107-1	238914	+59 1909	1.47 ± 0.47	9.50 ± 0.38	1.85 ± 0.19	-	12.73 ± 3.89
3917-01228-1	-	-	1.76 ± 0.21	9.29 ± 0.13	1.73 ± 0.07	-	10.42 ± 1.50
3930-00143-1	238928	+59 1916	1.12 ± 0.14	9.93 ± 0.18	1.70 ± 0.10	-	11.06 ± 1.91
3930-00383-1	-	-	1.00 ± 0.12	9.92 ± 0.16	1.74 ± 0.09	-	11.19 ± 1.56
3930-00519-1	-	+59 1920	1.03 ± 0.13	9.93 ± 0.18	2.16 ± 0.09	-	18.44 ± 3.11
3930-00524-1	174259	+59 1921	1.44 ± 0.22	9.41 ± 0.21	1.87 ± 0.13	1.78 ± 0.14	11.20 ± 1.95
3930-00551-1	-	-	1.10 ± 0.12	9.92 ± 0.16	1.53 ± 0.09	-	9.05 ± 1.37
3930-00665-1	-	-	1.64 ± 0.15	9.26 ± 0.11	1.64 ± 0.08	-	9.18 ± 1.00
3930-00681-1	-	-	1.25 ± 0.26	9.70 ± 0.26	1.38 ± 0.23	-	6.90 ± 2.29
3930-00783-1	174062	+59 1918	1.01 ± 0.11	9.98 ± 0.14	1.00 ± 0.09	-	4.37 ± 0.68
3930-00952-1	-	-	1.25 ± 0.29	9.73 ± 0.28	2.02 ± 0.17	-	16.04 ± 4.70
3930-01302-1	-	-	1.00 ± 0.08	9.99 ± 0.12	1.50 ± 0.07	-	8.35 ± 0.97
3930-01530-1	-	-	1.03 ± 0.10	9.89 ± 0.15	1.56 ± 0.08	-	8.84 ± 0.97
3930-01669-1	-	+58 1834	1.02 ± 0.13	9.85 ± 0.19	1.74 ± 0.10	-	10.34 ± 1.70
3993-00227-1	240189A	+56 2947A	0.99 ± 0.10	9.93 ± 0.15	0.88 ± 0.12	-	3.54 ± 0.68
3993-01107-1	240188	+55 2896	2.06 ± 0.13	9.09 ± 0.08	1.60 ± 0.07	-	8.01 ± 1.16
3993-01850-1	-	-	1.36 ± 0.08	9.56 ± 0.08	0.78 ± 0.10	-	2.67 ± 0.35
4006-00019-1	240237	+57 2714	1.46 ± 0.32	9.48 ± 0.29	2.37 ± 0.14	-	28.24 ± 6.54
4006-00340-1	-	-	1.65 ± 0.24	9.32 ± 0.16	1.76 ± 0.08	-	10.58 ± 1.47
4006-00629-1	219415	+55 2926	1.04 ± 0.09	10.00 ± 0.12	0.72 ± 0.13	-	3.12 ± 0.65
4006-00797-1	240226	+55 2918	1.80 ± 0.15	9.20 ± 0.07	1.79 ± 0.04	-	10.88 ± 1.34
4006-00832-1	-	+56 2967	2.08 ± 0.16	9.05 ± 0.09	1.62 ± 0.08	-	8.11 ± 0.99
4006-00890-1	-	+56 2957	1.44 ± 0.31	9.60 ± 0.28	2.17 ± 0.25	-	22.55 ± 12.01
4006-00980-1	240210	+56 2959	1.30 ± 0.38	9.68 ± 0.32	2.14 ± 0.20	-	17.13 ± 6.26
4006-01008-1	240224	+56 2963	1.30 ± 0.29	9.64 ± 0.26	1.78 ± 0.08	-	11.10 ± 1.98
4006-01039-1	219812	+55 2937	2.02 ± 0.16	9.07 ± 0.08	1.63 ± 0.07	-	7.86 ± 1.20

Table 3. continued.

TYC	Names HD	BD	$M/M_\odot$	log (age/yr)	log $L/L_\odot$	log $L/L_{\odot,\pi}$	$R/R_\odot$
4006-01055-1	-	-	1.13 ± 0.18	9.78 ± 0.23	1.60 ± 0.13	-	9.08 ± 1.87
4211-00383-1	-	+67 1028	1.17 ± 0.19	9.82 ± 0.22	1.38 ± 0.18	-	6.75 ± 1.93
4211-00438-1	-	+67 1024	1.27 ± 0.22	9.69 ± 0.23	1.56 ± 0.15	-	8.95 ± 2.17
4215-01352-1	-	+60 1847	1.32 ± 0.38	9.67 ± 0.31	2.30 ± 0.18	-	23.62 ± 7.79
4215-02018-1	-	-	1.54 ± 0.20	9.36 ± 0.16	1.54 ± 0.13	-	8.24 ± 1.34
4215-02349-1	-	+59 1923	1.03 ± 0.12	9.93 ± 0.16	1.59 ± 0.09	-	8.85 ± 1.49
4421-01222-1	-	+68 933	1.13 ± 0.21	9.83 ± 0.24	1.69 ± 0.16	-	10.41 ± 2.75
4421-01437-1	-	+68 937	1.16 ± 0.20	9.78 ± 0.24	1.42 ± 0.17	-	7.15 ± 1.93
4421-01706-1	-	+68 944	1.27 ± 0.23	9.66 ± 0.24	1.57 ± 0.17	-	8.79 ± 2.22
4421-01779-1	160723	+69 930	1.07 ± 0.14	9.88 ± 0.19	1.15 ± 0.14	-	5.19 ± 1.17
4421-02304-1	-	+68 931	1.08 ± 0.14	9.94 ± 0.17	1.68 ± 0.11	-	9.42 ± 1.95
4421-02783-1	-	+67 1023	1.17 ± 0.19	9.76 ± 0.23	1.48 ± 0.14	-	7.94 ± 1.73
4421-02880-1	159966	+68 938	1.22 ± 0.08	9.68 ± 0.10	1.68 ± 0.10	1.67 ± 0.09	10.51 ± 1.30
4428-00192-1	-	+67 1033	1.30 ± 0.22	9.66 ± 0.23	1.53 ± 0.17	-	8.59 ± 2.15
4428-00560-1	-	+68 958	1.28 ± 0.35	9.66 ± 0.32	2.05 ± 0.19	-	15.79 ± 5.32
4428-01506-1	-	+68 953	1.22 ± 0.13	9.74 ± 0.15	1.31 ± 0.10	-	6.79 ± 0.93
4428-01561-1	-	+68 951A	1.19 ± 0.20	9.74 ± 0.23	1.46 ± 0.15	-	7.78 ± 1.73
4428-01582-1	-	+69 935	1.09 ± 0.12	9.93 ± 0.16	0.73 ± 0.17	-	3.11 ± 0.91
4444-00200-1	-	+68 1063	1.20 ± 0.12	9.81 ± 0.15	0.93 ± 0.07	-	4.24 ± 0.48
4444-00717-1	184737	+68 1071	0.93 ± 0.04	10.06 ± 0.06	1.97 ± 0.09	1.67 ± 0.14	10.46 ± 2.13
4444-01116-1	-	-	1.18 ± 0.15	9.81 ± 0.19	1.55 ± 0.10	-	9.25 ± 1.53
4445-00579-1	187178	+68 1078	1.31 ± 0.19	9.59 ± 0.20	1.53 ± 0.18	1.62 ± 0.26	8.87 ± 2.66
4448-00021-1	184873	+69 1052	1.89 ± 0.12	9.09 ± 0.08	1.02 ± 0.20	1.66 ± 0.16	6.97 ± 1.63
4448-00811-1	-	+70 1068	1.29 ± 0.23	9.63 ± 0.22	1.44 ± 0.15	-	7.60 ± 1.55
4448-01402-1	-	-	1.10 ± 0.13	9.93 ± 0.16	1.49 ± 0.09	-	8.39 ± 1.43
4448-01430-1	-	-	1.22 ± 0.17	9.82 ± 0.19	1.49 ± 0.10	-	9.02 ± 1.53
4448-01464-1	-	-	1.10 ± 0.10	9.90 ± 0.14	1.17 ± 0.09	-	5.66 ± 0.76
4449-00492-1	-	+69 1059	2.09 ± 0.20	9.08 ± 0.12	1.63 ± 0.10	-	8.48 ± 1.47
4449-01168-1	-	+70 1082	1.07 ± 0.08	10.01 ± 0.11	0.84 ± 0.12	-	3.68 ± 0.73
4449-01170-1	-	+69 1062	1.25 ± 0.19	9.66 ± 0.22	1.39 ± 0.16	-	7.17 ± 1.60
4449-01543-1	-	+69 1061	1.55 ± 0.19	9.39 ± 0.15	1.09 ± 0.13	-	4.65 ± 0.85
4449-01785-1	-	-	1.03 ± 0.08	9.94 ± 0.11	0.78 ± 0.08	-	3.31 ± 0.42
0435-03989-1	-	-	2.02 ± 0.11	9.09 ± 0.07	1.60 ± 0.06	-	7.97 ± 0.96
			1.37 ± 0.16	9.52 ± 0.15	1.25 ± 0.12	-	5.90 ± 1.03
1058-01329-1		+08 4256	1.37 ± 0.13	9.51 ± 0.12	1.33 ± 0.09	-	6.55 ± 0.86
			1.90 ± 0.09	9.15 ± 0.05	1.58 ± 0.06	-	8.19 ± 0.82
1208-00699-1	-	-	1.64 ± 0.22	9.34 ± 0.15	1.89 ± 0.12	-	13.89 ± 2.47
			1.13 ± 0.11	9.83 ± 0.14	1.64 ± 0.10	-	11.03 ± 1.73
1423-00270-1	-	+20 2473	1.01 ± 0.10	9.86 ± 0.15	1.65 ± 0.08	-	9.58 ± 1.23
			1.27 ± 0.07	9.52 ± 0.07	1.84 ± 0.05	-	11.38 ± 1.07
2822-00812-1	-	+40 303	1.58 ± 0.18	9.38 ± 0.13	1.80 ± 0.10	-	12.36 ± 2.02
			1.13 ± 0.12	9.84 ± 0.15	1.59 ± 0.08	-	10.10 ± 1.48
3105-00152-1	-	-	1.22 ± 0.08	9.68 ± 0.10	1.66 ± 0.04	-	10.62 ± 0.83
			1.48 ± 0.09	9.41 ± 0.08	1.80 ± 0.05	-	12.08 ± 0.99
3122-02192-1	-	-	1.26 ± 0.06	9.66 ± 0.07	0.69 ± 0.06	-	2.87 ± 0.29
			1.02 ± 0.06	9.95 ± 0.08	0.57 ± 0.07	-	2.54 ± 0.29
3227-00413-1	216536	+43 4329	1.70 ± 0.34	9.27 ± 0.20	1.99 ± 0.17	-	14.77 ± 4.09
			1.11 ± 0.11	9.83 ± 0.16	1.66 ± 0.10	-	10.96 ± 2.36
3319-00892-1	20076	+48 873	1.70 ± 0.15	9.27 ± 0.10	1.70 ± 0.07	-	9.88 ± 1.19
			1.33 ± 0.11	9.55 ± 0.12	1.50 ± 0.09	-	8.29 ± 1.10
3805-00709-1	77819	+53 1309	1.30 ± 0.05	9.55 ± 0.05	1.09 ± 0.08	1.52±0.19	6.28 ± 1.28
			1.90 ± 0.17	9.13 ± 0.10	1.35 ± 0.15		6.81 ± 1.44
4211-00364-1	-	+67 1020	1.27 ± 0.10	9.62 ± 0.11	1.48 ± 0.06	-	8.06 ± 0.76
			1.72 ± 0.13	9.26 ± 0.09	1.62 ± 0.07	-	9.47 ± 0.94

Notes. The following columns represent: (1-3) identification from SIMBAD, (4-8) astrophysical stellar parameters and their uncertainties (mass, age, luminosity from this work, luminosity calculated from parallax (if available) radius).